Construction of an Aurora Camera in North Dakota to Aid in Citizen Science and Space Weather Applications

Vincent Ledvina[1], Elizabeth MacDonald[2], Wayne Barkhouse[1], Timothy Young[1]

1. University of North Dakota
2. NASA Goddard Space Flight Center

Introduction

The aurora is a phenomenon that attracts many audiences, including researchers and the public. Visual analysis of auroral strength is important for scientists; the appearance of aurora (shape, movement, color, etc.) is a proxy for certain magnetic and ionospheric properties. Furthermore, rare and transient types of aurora such as STEVEs and substorms benefit from increased observations and detections, especially at mid-latitudes where these events occur. The public also benefits from visual auroral data, especially when trying to predict its strength in real time. Aurora guides, photographers, and enthusiasts all use visual observations of the aurora in their daily lives. Aurora cameras are one of the best tools scientists and aurora chasers can use to visually study and predict how the aurora behaves, and offers some unique advantages:

1. Unlike indirect inferences such as solar wind telemetry, or more generalized assumptions based on K-indices or magnetometer data, aurora cameras observe the aurora directly.

2. Aurora cameras offer location-specific data. The aurora behaves differently as geographic location varies. Scientists may correlate observations with certain auroral structures and aurora chasers may value a local view of conditions.

3. Aurora cameras produce high time-resolution views of the aurora. Many aurora cameras capture images in quick succession, some even offering video framerates. Rapid image capture is helpful for studying intense aurora in which structures move quickly.

While there are hundreds of aurora cameras across the world, there is very limited coverage in North America at mid-latitudes. Given the benefits, our team, led by UND sophomore Vincent Ledvina, presents plans for a high-quality aurora camera setup consisting of north-facing and allsky cameras at the Martens Observatory in North Dakota. This setup will record real-time video of the aurora with live broadcasting capabilities, and offer archival data retrieval.

STEVE Aurora near Martens Observatory; September 2019 (Credit: Vincent Ledvina)

Imaging

The aurora camera setup will consist of a north-facing Sony a7sii mirrorless camera and a Sony 24mm f1.4 lens, along with an allsky camera consisting of the ZWO ASI174MC camera head and a Fujinon f1.4 fisheye lens. The a7sii is used in many other aurora cameras and will provide 24fps 4k real-time video of the northern sky. The allsky camera and lens were selected based on the Boreal Auroral Camera Constellation (BACC) in which this combination has proved well-suited for auroral observations. Due to the large field of view (1200km^2 at ionospheric altitudes) this camera is well-suited to observe diffuse aurora, airglow, and meteor strikes.

Sony a7s ii camera (credit: Sony)

ZWO ASI174MC
(credit: High Point Scientific)

Sony 24mm f1.4 GM
(credit: dpreview)

Fujinon f1.4 Fisheye
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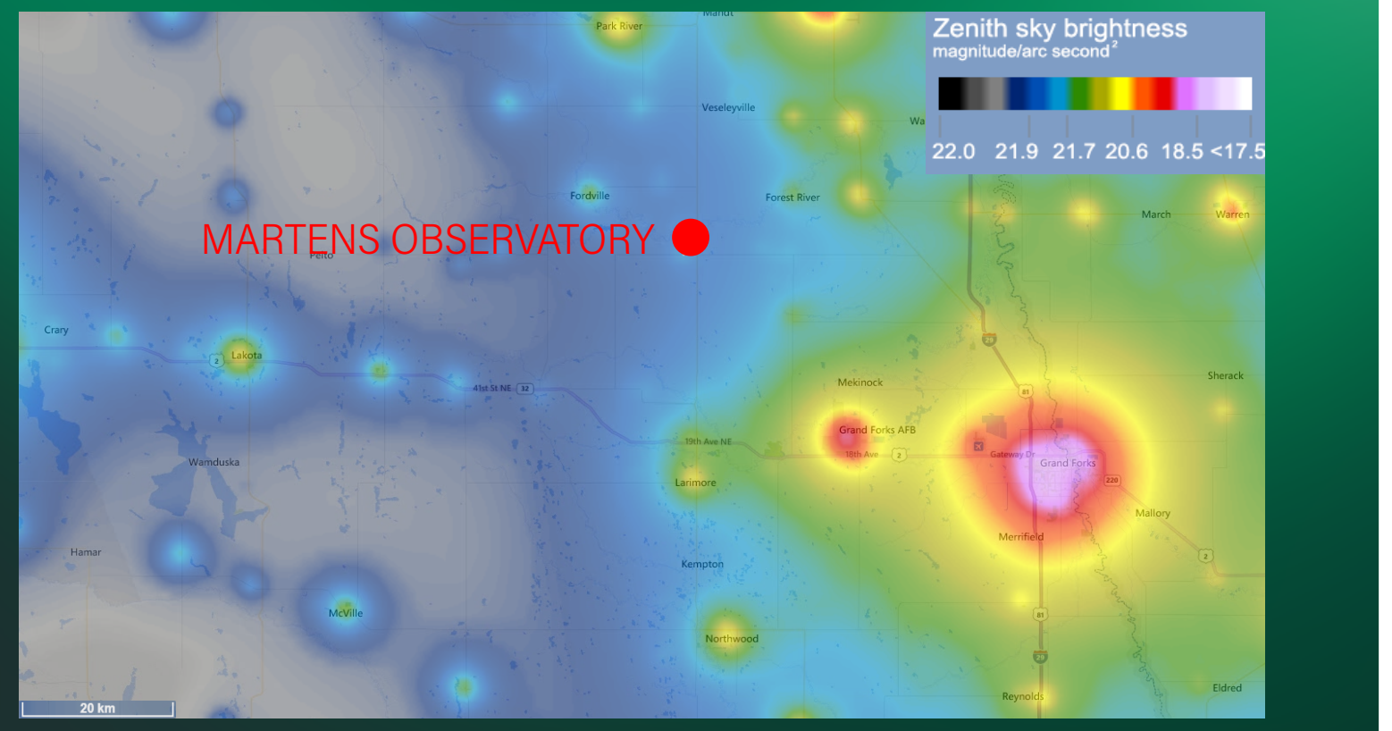
Location

The cameras will be located at Martens Observatory, operated by the University of North Dakota. As a UND student I have a unique opportunity to utilize this site, chosen for its low light pollution (Bortle-2) and on-site internet. At 48.1˚N, the camera will be positioned to experience strong auroral events and rare phenomena like STEVEs. The cameras will be housed in a plastic dome and attached to a trailer.

Martens Observatory grounds (credit: Tim Young)



Light pollution heat-map (credit: lightpollutionmap.info)

Functionality

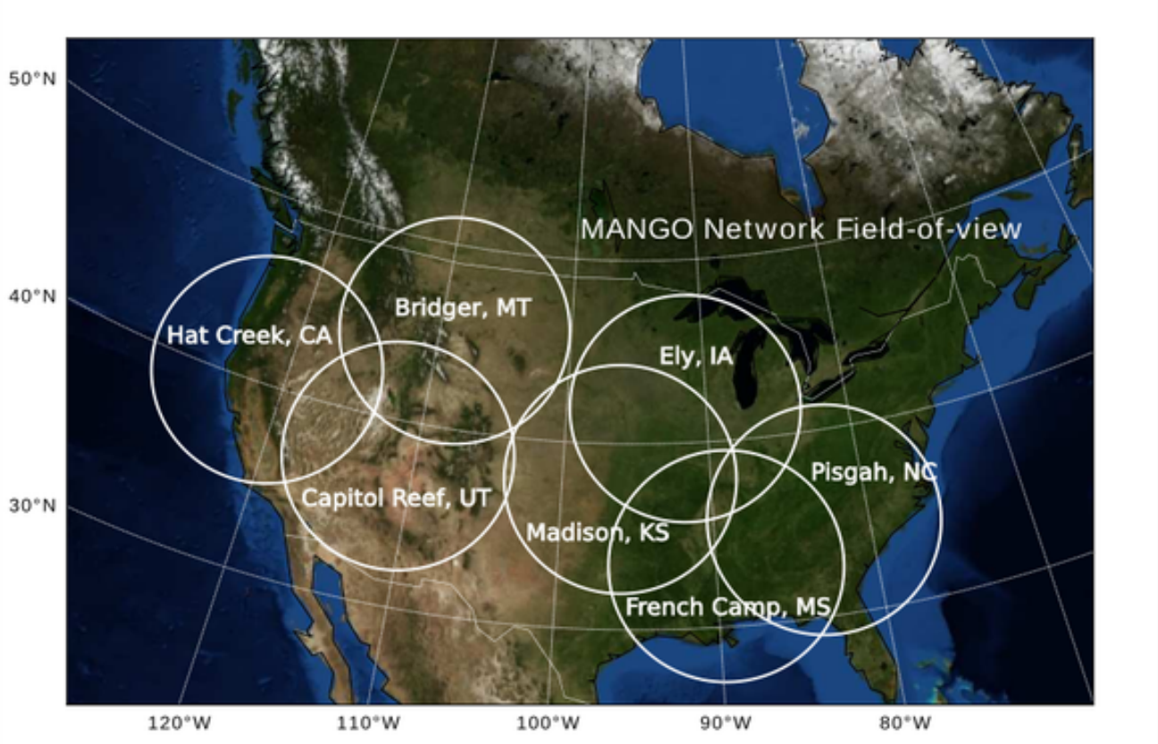
Both cameras will have internet connectivity and will stream images to a website. The Sony a7sii will also livestream video to YouTube. The cameras will tweet when aurora is visible. This will be integrated into the Aurorasaurus project. All the data will be offloaded to a storage server where users can browse through different days and download the raw images.

Impact

The aurora camera installation is unique in that it will benefit many scientific and public communities, as well as integrate well into other projects and efforts.

Citizen Science

The citizen science applications of the aurora cameras are significant. An aurora camera in North Dakota provides more opportunities to observe rare mid-latitude phenomena such as substorms and STEVEs. Because the data has high time resolution, these phenomena can be studied in new ways. The allsky camera provides another perspective allowing for quantitatie estimates of height and extent.
Besides aurora, images from the allsky camera will be integrated into other citizen-science projects such as the Mid-latitude Allsky-imaging Network for GeoSpace Observations (MANGO) and Cameras for Allsky Meteor Surveillance (CAMS).



MANGO camera network - camera locations
(SRI International)

Novel "dune" aurora from Finland (credit: Pirjo Koski)

Community

This project will be integrated into North Dakota's largest astronomy club, the Northern Sky Astronomical Society. It will serve as an aurora-chasing tool for online groups such as the Great Lakes Aurora Chasers (50,000+ members) and Upper Midwest Aurora Chasers (4000+ members). This project will collaborate with others' educational efforts to link ground-truth data with space weather data. If you are interested in collaborating, contact Vincent Ledvina at vincent.ledvina@und.edu.

Acknowledgements

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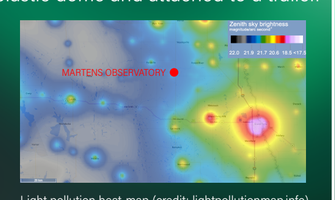

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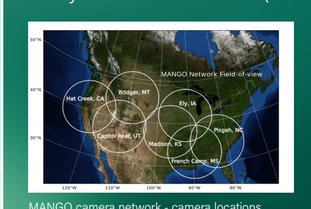

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